Satellite imagery for change detection in the sub-Antarctic: using Heard Island as a proof of concept

Arko Lucieer*, Sharon Robinson[#], and Jenny Scott*
*University of Tasmania
School of Geography and Environmental Studies
Private Bag 76, Hobart, Tasmania 7001, Australia
Email: Arko.Lucieer@utas.edu.au

[#]Institute for Conservation Biology and Law
School of Biological Sciences
University of Wollongong
Northfields Avenue, NSW 2522, Australia

Heard Island is a pristine and remote volcanic sub-Antarctic island in the Southern Ocean, south of the Antarctic Polar Frontal Zone (APFZ). Heard Island arguably provides one of the most rapidly changing environments for plant growth in the sub-Antarctic region, due to extensive and rapid glacial retreat which has been accelerated by rising temperatures. There has been minimal human impact on the ecosystem of Heard Island, but warmer conditions will increase the ease for invasion of new species. Its location, climate conditions, and pristine nature make Heard Island an ideal site to study the regional effects of climate change. Up-to-date and accurate spatial information on vegetation is of crucial importance to manage this World Heritage Area and to study its changes. During previous expeditions to Heard Island in 1987/1988 and 2003/2004 terrestrial plant ecology has been studied and vegetation maps have been produced from field samples and aerial photography. These field surveys are expensive, labour intensive, potentially intrusive, and often only cover small areas. Because of the island's remoteness and harsh environment, satellite imagery provides advanced and cost-effective means to map its vegetation cover and to quantify vegetation changes.

The first step in identifying vegetation changes is the development of a methodology to reliably map Heard Island's vegetation communities. Image classification is a suitable technique to translate the spectral information in a satellite image into thematic vegetation classes. Transition zones between vegetation types (ecotones) are abundant in natural areas like Heard Island, therefore thematic and spatial uncertainties play an important role in classification of vegetation. Quantification of the spatial extent of transition zones is crucial for a solid understanding of the effects of climate change on vegetation types, as transition zones are most sensitive to environmental changes. *This paper presents the first study that applies fuzzy classification and change detection based on high-resolution satellite imagery for sub-Antarctic vegetation mapping. The main objective of this study is to develop and apply fuzzy classification and change detection techniques to map sub-Antarctic vegetation types and quantify uncertainty across transition zones from high-resolution Quickbird and IKONOS satellite imagery of Heard Island.*